Tools for Performance Evaluation and Tuning on Parallel Computers
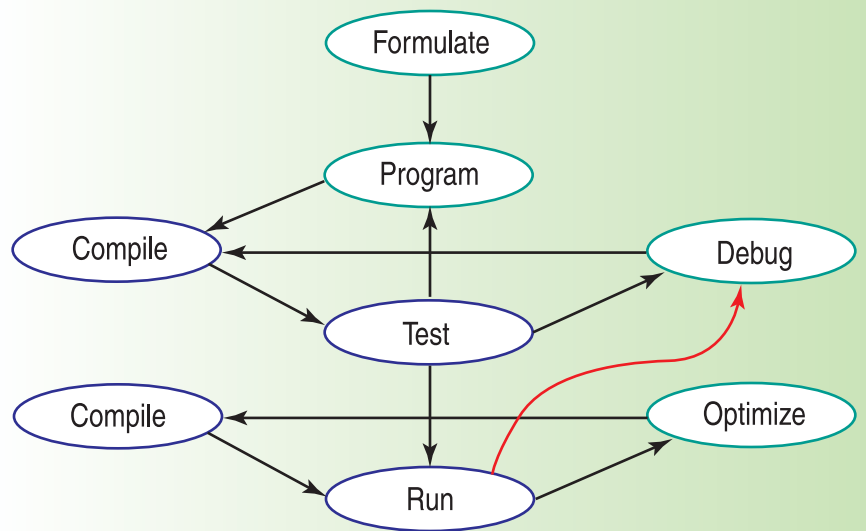

Figure 1. Performance tools, such as visual profiler (VProf), measure performance and help application developers optimize code to run on large, distributed systems.

High-performance algorithms and parallel computing are gaining significance in the scientific community because of the increasing demand for numerical computation. Scientists in a growing range of fields can now model and solve complex and computationally intensive problems. One downside to using distributed supercomputers is the difficulty of designing efficient algorithms and programming in parallel. An application's performance is highly dependent upon how a programmer organizes computationally intensive algorithms and uses message-passing libraries for concurrent execution among many processors.

To assist developers who use distributed computer systems, Sandia researchers are developing software tools for evaluating and enhancing performance, particularly in the areas of hardware-performance monitoring and communication-performance analysis. Such tools have become a necessity for improving application performance, a highly desirable outcome that effectively results in more computational time and, thus, less need to purchase additional processors.
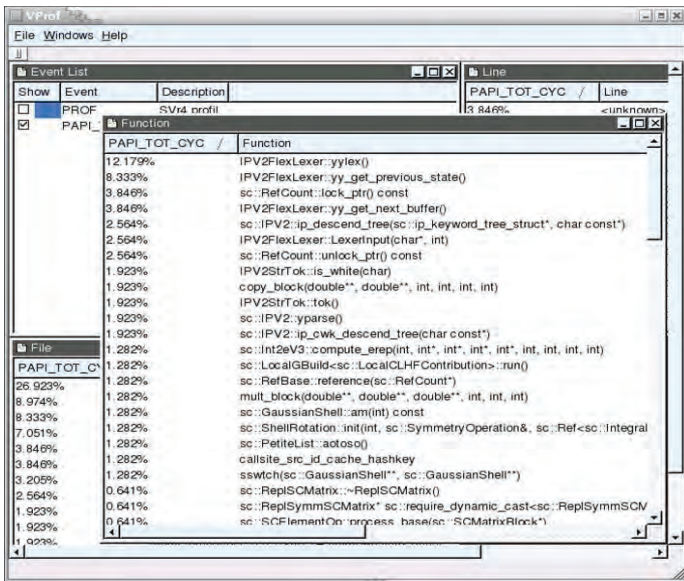
Figure 2. VProf display of time spent by function call. This display helps developers measure the performance and efficiency of scalable algorithms.

Processor Use and Hardware-Performance Monitoring

The Visual Profiler (VProf) is a software tool developed by Sandia researchers to optimize the performance of applications and evaluate algorithm efficiency. VProf provides routines to collect statistical-profiling information and programs to view execution profiles. Profile data is used to generate performance summaries sorted by source code line, file, and function.

The abilities to measure hardware events and report the performance of multiple nodes of a computer cluster are among the powerful features of VProf. VProf can track many different hardware events, including cache misses, TLB misses, branches taken and not taken, pipeline stalls, and floating-point operations. VProf can also generate profiles for all nodes of a distributed system. Once the profiles have been generated, a command line or graphical interface can be used to easily discern problem areas in an application. The graphical interface was recently redesigned with an emphasis on ease of use.

As an open-source and freely distributed tool, VProf has received several enhancements from the open source community. VProf was designed for research into CPU performance as well as measure an application's efficiency in using system resources. VProf has been widely used throughout Los Alamos National Laboratory, Lawrence Livermore National Laboratory and Sandia National Laboratory to measure and improve the performance of some of the most critical applications. Code teams have used VProf to identify problem areas in their applications. This problem identification has led to significant performance improvements by enabling the teams to concentrate their optimization efforts on narrowly defined segments of the applications.
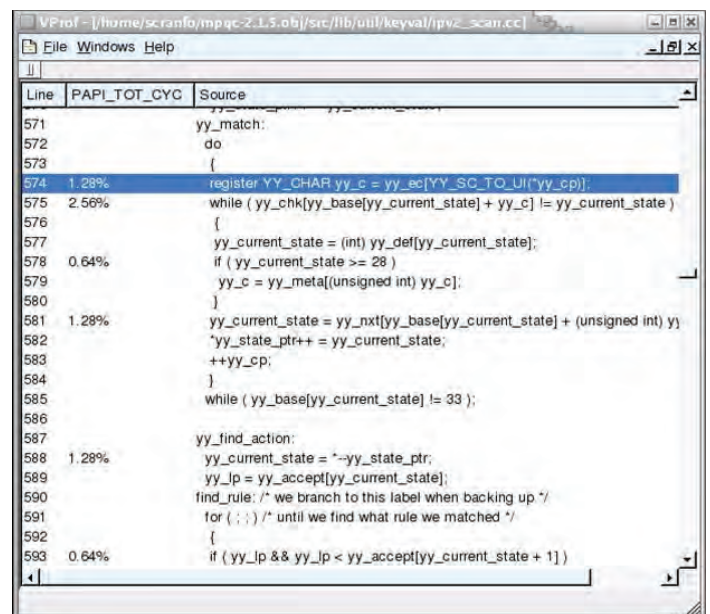

Figure 3. One of the most powerful features of VProf is being able to break down time spent at the source-line level of an application.